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ABSTRACT

Developers who use the systems approach to training begin developing a lesson by identifying the skills and knowledge to be learned and the kinds of learning experiences required. The next step is to develop instructional segments. These segments include all instructor and trainee activities required to master the skill. Learning segments include the following components: presentation, explanation/demonstration, transitional practice (including cues and feedback), criterion practice (plus additional feedback), and a criterion test. Most of the learning takes place during active practice. Demonstrating and cuing are used to achieve error-free learning. The progression of the sequence is logical, with the criterion test forming the basis for student goals. (This module uses materials that might be included in a learning segment for nuclear power plant operators to illustrate the workings of the learning segment model. Step-by-step procedures for developing effective simulated practice are provided, including guidelines on scaling down practice and altering inputs, actions, and standards.) (MN)

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Model of a Learning Segment

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MODEL OF A LEARNING SEGMENT

Training programs are normally composed of courses, which in turn are made up of units. The units themselves are further divided into lessons or modules, which are usually the smallest administrative unit of instruction. The terms "lesson" and "module" are often interchangeable, although "module" implies that material is competency-based and includes a performance test.

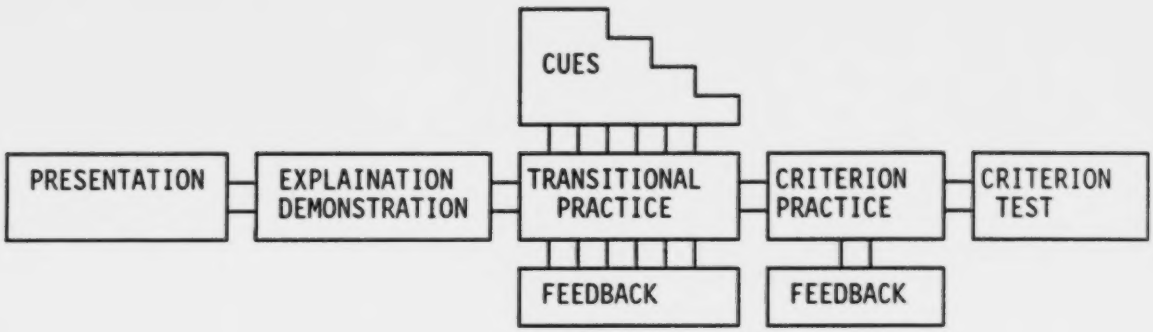
Lessons and modules vary in size. Some cover one learning objective while others cover many. Lessons also vary in terms of the amount of content and the types of learning that take place. When lessons or modules are developed for a "conventional" program, the decisions about how many objectives and how much content to be included are usually based on administrative convenience.

However, systems-based training has been found to be more effective than the conventional approach. The key distinction between the two training methods are how the materials are developed and the resulting structure. Developers of conventional programs tend to begin developing a lesson with the most easily imagined part--the lecture. First the blocks of content are formed into lecture sessions, then laboratory practice is added, and finally objectives and tests are written--and the lesson is regarded as complete. However, materials developed this way often do not provide an effective or efficient means of causing learning.

Developers who use the systems approach to training develop the lesson in the reverse order. Rather than initially focus on the lecture development, they begin by identifying the skills and knowledges to be learned and the kinds of learning experiences required. Instructional segments are developed which include all instructor and trainee activities required to master the skill. A problem often faced by the developer is that of converting blocks of content which had been organized into lessons for administrative reasons into segments of instruction that focus on causing learning.

Components of a Learning Segment

The following model illustrates the basic components of a learning segment. It provides a useful method of examining the types and sequence of activities necessary for performance-based training.



Model of a Learning Segment

As the model implies, most of the learning takes place during active practice. The principle reason for demonstrating and cueing is for error-free learning. Knowledge of results constantly reinforces and corrects the practice. The progression is logical, and the presentation and explanation also follow a logical pattern. The criterion test forms the basis for student goals. If the task being taught is job-relevant, we then have all six characteristics of effective instruction in one short segment.

Each component of the segment is important in and of itself. The sequence is also important. If the components are not in the correct order, the instruction is weakened.

The Presentation

The presentation starts the learning process. Three questions should be answered: What is the trainee going to learn to do? Why must the trainee learn this material or process? And, how does this learning fit into the "big picture?"

What the trainee is going to learn to do is often omitted in traditional training. This is because the lesson is designed for the trainee to learn about something, rather than to learn to do something. However, even if later lessons will apply what the trainee has learned about, the initial training should still be goal-oriented. Whether it's conducting a plant start-up from cold shut-down or performing a surveillance, effective instruction begins with what will be learned.

Second, why must the trainee learn? Job relevance is a critical issue here, and again this aspect is constantly overlooked in traditional training. We assume that the trainees will learn rather than motivate them to learn. The assumption is not entirely wrong: trainees captured in a simulator (or classroom) usually learn something; the difference lies in how much they learn in a given period of time.

Third, how does this learning fit into the "big picture?" Establishing the context of the lesson adds motivation. For example in a training program for commercial cooks, one of the lessons might cover de-scaling a ban-Marie. Few students would have any idea what they were about to learn and as a result few would be motivated to learn. However, if they were told that a ban-Marie was used in a highly temperature-sensitive form of French cooking and that even moderate scaling could ruin the dish being prepared de-scaling would become important. People catalog what they learn in context with things they have already learned. To enhance instruction the instructor needs to put the new learning in context with things the trainee already knows.

These, then, are the key ingredients of an effective presentation: what will be learned, answered in as clear a statement as possible; why it should be learned, demonstrated in terms of the importance and job relevance of the lesson; how it will fit into the larger picture, so that the trainee can put the lesson in context.

The Explanation/Demonstration

This component assures that the student understands the tasks that he is expected to practice and learn. Supporting knowledges should be explained adequately according to the desired learning level. Carefully presented demonstrations of how the knowledge will be used or the skills performed help prepare the trainee for practice.

Demonstrations can be in one of two forms: demonstrations of a task to be performed; or a demonstrations that illustrate the concepts or principles to be learned. Even with "academic" materials the demonstration is an important part of the learning process.

In some instances a demonstration may be either impossible or impractical. However, before deciding this you should first look at at the associated lessons; you may find that some of the components of the learning segment have been parcelled out into other blocks of content. The more appropriate decision may be to reorder part of the training program, rather than writing off a demonstration. If the decision is still not to demonstrate, then the clarity and the richness of the explanation becomes even more important.

One of the major distinguishing characteristics of an excellent instructor is the richness of his explanation. The best instructors understand the importance of using clear examples and comparisons to support the concepts, principles, and procedures to be taught. A clear explanation and demonstration of the lesson material is necessary to ensure that the trainee understands what he is to learn and is adequately prepared to begin practice.

Cues

Cues are visual, verbal, or auditory prompts that help the trainee perform correctly the first time. Cues are the key element in providing error-free learning; trainee proficiency improves, cues are withdrawn--hence the shape of the figure represents cues. The rate that cues are withdrawn should be based on trainee development; not a uniform straight line.

The decision of when and how to cue is also based on the level of the trainee development. For example, early in a training program, while trainees are learning new skills the first time, instructor cues may be quite detailed. This could include reading the steps of a procedure and prompting each action. Later, a cue may be no more than asking an SRO candidate, "Have you checked on torus temperature lately?"

Thus, to be effective, cues must be tailored. On one hand, you want the students to perform correctly the first time; on the other hand, you want them to progress as far as they can with instructor assistance. The skilled instructor masters this balancing act.

Feedback

Feedback is the second instructor input that supports the error-free learning process. Feedback includes three behavioral processes: reinforcing trainee successes, identifying weaknesses, and providing remediation.

Once you have cued a student into performing correctly, he needs to know that he was successful. Having success recognized is highly motivational, and at the same time ensures that the behavior is repeated.

In addition to reinforcing good behavior, feedback also serves to identify poor behavior. However, it's rarely effective to identify all of a trainee's weaknesses; rather you should identify only those that should be corrected most immediately. This means being selective about what you have a student concentrate on. Some instructors become concerned that, by not identifing a particular weakness, that weakness is somehow reinforced; this is not the case, because reinforcement is a positive act. However, it is possible that if the unidentified errors were significant, it would be the source of future performance problems. Again, the instructor must master a balancing act.

The final element of feedback is remediation. Identifying problems without providing remediation is of little value. To remediate effectively you must determine what the student does understand, explain the material detail, and follow-up to determine if learning has taken place.

An example might sound something like this:

"Didn't you realize that doing that would cause....?"

"Oh, you didn't. Well, in this kind of a situation ...."

"Is that clearer now?"

"Good. So, if the future if that happens again what will you be looking for?"

"That's right. The same thing can happen when you...."

The timing of feedback changes as the student gains more experience. Early in training feedback and cues are mixed together. You might hear an instructor saying, "Turn that one on the left. Just a little further. Good. Now the second one. That's it." Later on, especially in criterion practice, feedback comes after the exercise has ended.

Successful feedback includes reinforcing trainee successes, identifying major weaknesses, and providing remediation. To do all these effectively requires that the feedback (especially remediation) is a pre planned and well- structured part of every learning segment.

Practice

There are two different types of practice that may be used during learning: criterion practice and transitional practice. Criterion practice should be included in every learning segment; this is the trainee's opportunity to practice before being evaluated. Criterion practice is conducted under the same conditions as a test, but without a final grade--a sort of a non-threatening dress rehearsal. If criterion practice is successful the trainee is then evaluated; if it is not successful the trainee returns to transitional practice or attempts criterion practice again.

Transitional practice is not necessary in all situations. It is designed to help the trainee bridge the gap between his entering ability and the criterion test. The practice can be scaled-down (made less difficult) as necessary, by changing the conditions, required behaviors, or standards. For example, transitional practice might involve breaking a task into component skills and knowledges and practicing individually before practicing them together. As the student meets with success, the next exercise is scaled up until he is ready for the criterion practice. The goal of transitional practice is for the student to complete each practice exercise successfully.

Developing Effective Simulated Practice

The best kind of practice involves actual job inputs, actions and outcomes. Unfortunately this is not always possible, in which case effectively developed simulated practice can serve as a substitute. The closer the simulated practice conditions are to actual job conditions, the more effective the practice. In developing simulated practice, you should strive to make each of the inputs required actions and outcomes as similar to actual job performance.

Inputs

The following are two examples of transition from an actual job task to a simulated input:

Job Task:	Shoot at a moving target
Job Input:	A live, moving target
Effective Simulation:	A stationary dummy
More Effective Simulation:	A moving dummy

Job Task:	Diagnose a malfunction in a radio
Job Input:	A malfunctioning radio set
Effective Simulation:	A printed description of malfunction symptoms
More Effective Simulation:	A radio set or mock-up with a built-in malfunction

This is an area where most licensed operators feel they have their act together. What could be better than a replica simulator for simulating inputs. For the most part they are right; however, consider that during the period 1983-84, 49 percent of the reported events were the result of human performance problems. One specifically cited area of human performance problem is the interface between individuals in the control room: miscommunications, incomplete information, etc. This is an area were many simulator instructors opt for less than effective simulation.

When the input is in verbal form, the most effective simulation would be the spoken word from someone realistically role-playing and using standard communication devices. Less effective is an instructor role-playing but shouting from the instructor console; least effective is an instructor standing on the control room floor passing information without role-playing.

Required Actions

During practice the required actions should simulate actual actions as closely as possible. In the context of simulator training consider the following example:

Job Task:	Analyze an emergency situation
Job Action:	Analyze the situation under stress in real time
Least Effective Simulation:	Analyze a written situation with no time limit
Effective Simulation:	Analyze an unanticipated situation in real time
Most Effective Simulation:	Analyze an unanticipated situation under induced stress within a compressed time period

The first two levels are typically seen in written testing and simulator evaluations respectively. The most effective simulation is too seldom used, even though a machine with an effective fast-time option does an excellent job of inducing stress.

Outcomes

The practice should be designed so that the simulated outcome is very similar to the actual job outcome. For example, if the task is to tune a radio set to obtain a signal meeting certain standards, the simulation should be designed so that trainee will hear the signal if he follows the correct procedure.

Scaling Down Practice

The purpose of transitional practice is to bridge the gap between entering ability and criterion performance. In some cases, transitional practice is the same as criterion practice except for instructor cues. For more difficult tasks, the task may be divided into component parts, or "scaled down."

Scaling down practice is to make the practice less difficult during the early stages of learning. You can accomplish this by by altering the **inputs**, the **actions**, or the **standards** for the outcomes. At the same time, scaling down must be systematic enough to allow you to scale up easily during the later learning stages.

Altering Inputs

Probably the most effective means for altering inputs is by using mediating inputs. These are additional inputs presented at the same time as the criterion input. Some examples of mediating inputs are:

- A diagram of a movie projector with the film properly threaded, to help the student to follow when threading the film;
- A checklist to follow while assembling a piece of equipment;
- A flowchart of an lengthy written procedure to illustrate the sequence of steps and precautions until the written procedure is memorized.

The mediating input makes it easier for the student to learn, because it does a better job of prompting the correct actions. During transitional practice, the correct actions become associated with the criterion input, and the mediating input is withdrawn.

The flow chart on the opposite page is an example of a mediating input. A power plant found that for normal operation it is more effective to list the precautions and procedural steps in separate sections. However, this made it more difficult to follow the procedure and perform the correct actions. The flow chart was used to aid the students in learning to implement the procedure.

Other ways of altering inputs to make tasks less difficult during the early stages of learning include the following:

1. Slowing Down the Presentation of Inputs

   You can achieve this by giving the student more time between each input. For example, as the instructor, when role-playing plant personnel you can increase the time available for students to react. As the students learn you can the quicken the pace, scaling back up to criterion speed.

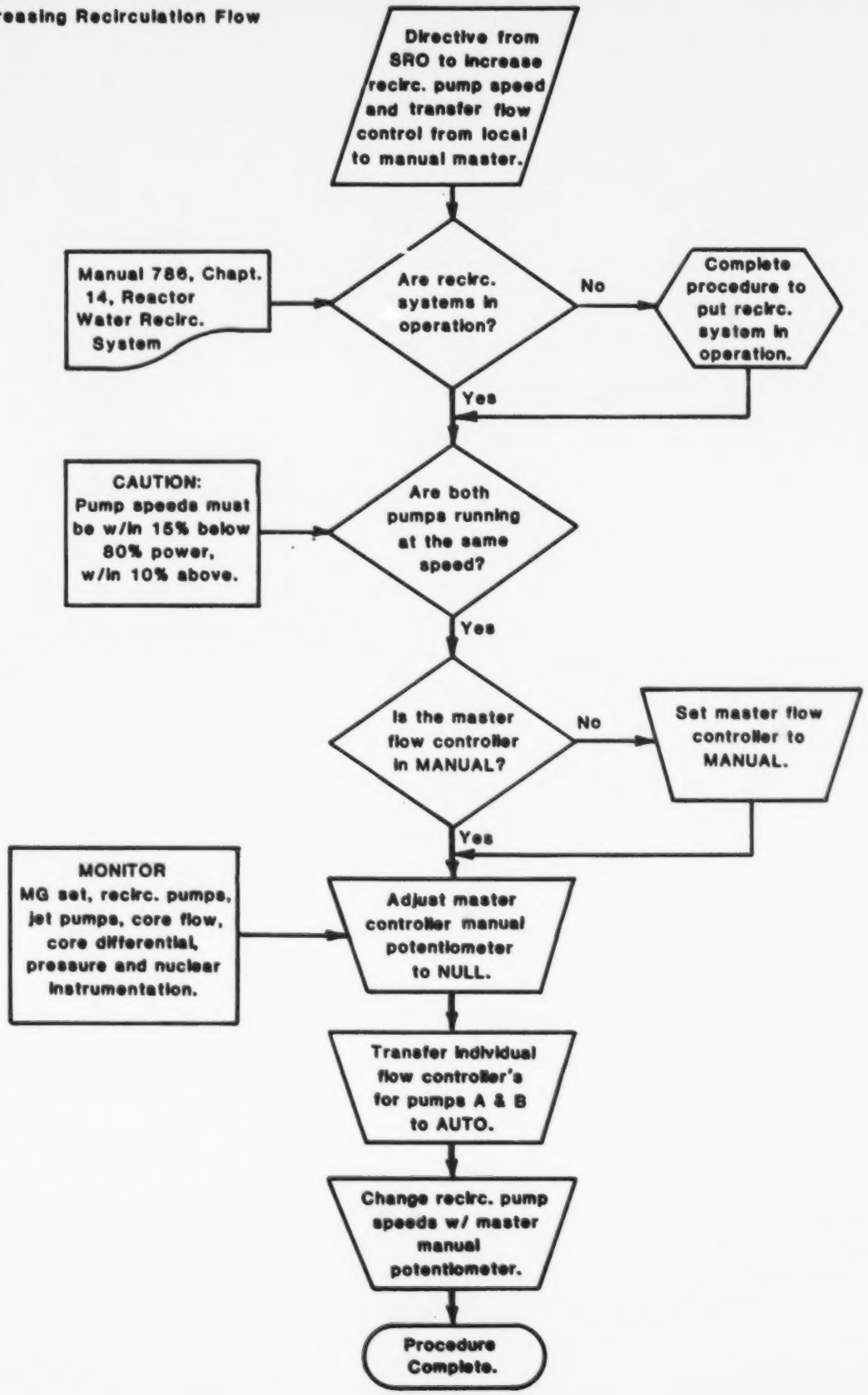
2. Removing Distracting Stimuli.

   On the job it is sometimes necessary to perform one task in concert with another, but learning both tasks simultaneously can cause real problems. To overcome this, you can limit the number of inputs that a student has to deal with at one time (so-called "part-training"). You can accomplish this easily in a replica simulator by having the student learn the primary tasks while you perform the companion tasks.

3. Simplifying the Input

   Probably the most common example simplifying an input is to interpret the initial data for the student. You only need to do this once before the practice can be scaled back up.

Increasing Recirculation Flow


Directive from SRO to increase recirc. pump speed and transfer flow control from local to manual master.
Are recirc. systems in operation?
No
Complete procedure to put recirc. system in operation.
Manual 786, Chapt. 14, Reactor Water Recirc. System
Yes
CAUTION: Pump speeds must be w/in 15% below 80% power, w/in 10% above.
Are both pumps running at the same speed?
Yes
Is the master flow controller in MANUAL?
No
Set master flow controller to MANUAL.
Yes
MONITOR MG set, recirc. pumps, jet pumps, core flow, core differential, pressure and nuclear instrumentation.
Adjust master controller manual potentiometer to NULL.
Transfer individual flow controller's for pumps A & B to AUTO.
Change recirc. pump speeds w/ master manual potentiometer.
Procedure Complete.

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The key objective of scaling down inputs is to increase the rate at which the student learns to associate the inputs with the correct action. The next step is to transition to a job-like environment--that is, scale up to the criterion input.

Altering Actions

Another area where scaling down may help is altering the students actions. This may be done in place of altering inputs at the same time.

The process of learning actions has been broken down into three steps: associating the input with the action; discriminating between similar actions; and completing the action correctly. Once an action is learned the three steps merge into a single action. For training purposes, however, it is helpful to examine the three steps separately. This technique of breaking down the learning process and teaching each step separately is called "Recognize - Edit - Produce" or simply REP.

The first step is to teach the trainee how to recognize when the action is required; this may involve anything from memorizing key symptoms to diagnosing plant conditions in a simulator. The second step is to edit the responses of others; the key emphasis here is discriminating between possible actions. The third step is to produce the desired outcome.

REP can help an instructor increase the level or active practice in the simulator by having the students observe and critique each other. Remember that, if you use this technique, you should critique the critique.

Altering Standards

In addition to altering inputs and actions, you can make the practice less difficult by altering the standards for the outcomes. You then raise the standards as the student progresses, until the he is satisfying the job criterion. Standards that are easily altered are those dealing with speed, accuracy, completeness, smoothness, etc.

Summary

One of the key features of a systems-based training program is the structure of the learning segments. Whereas conventional training programs often block the segments of content according to purely administrative reasons, the segments of systems-based training programs are arranged so that each one is self-contained and complete.

A complete learning segment has eight identifiable components:

1. The content or skill is presented;

2. The content or skill is explained and if possible, demonstrated;

3. The trainee practices the skill; generally this begins with a scaled-down practice which later transitions to criterion practice;

4. The trainee is cued during the transitional practice so that he learns error-free;

5. The trainee receives feedback, both during and following the transitional practice;

6. When the transitional practice has been completed, the trainee practices under job-like conditions (criterion practice);

7. The criterion practice is followed by more feedback;

8. The segment ends with the criterion test.

Most instructors scale down practice instinctively when they see students struggling. This is effective and should continue, but to have a greater effect, the scaling down should be planned. Identify those points in the lesson or exercise when you anticipate student difficulty and scale them down; at the same time, plan how you will scale up the practice once the learning is complete. Failing to effectively scale up is a common pitfall. Several plants have run into problems with the NRC when the instructors scaled down to meet student needs but have not scaled back up to meet training requirements.